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Overview of Li-Fi Technology

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Abstract - *Li-Fi that is light fidelity is one of the future technologies in wireless communication sector. It is a bidirectional, with a very high speed and is a fully networked communication which is wireless technology similar to Wi-Fi. In the present era, Wi-Fi is the most trending domain. As internet users almost double every year, there is an enormous load on radio spectrum that leads to congestion. To get better bandwidth, efficiency and speed, a new technology Li-Fi has evolved.. Li-Fi can be simply put to be Wi-Fi but instead of radio waves light is used as a medium. Here, data is transmitted using light whose intensity varies faster than human eye to capture. Instead of using modems, Li-Fi uses LED bulbs with transceiver. Data transmission in Li-Fi is about 100 times faster than Wi-Fi. Here, in this paper we explore the need for Li-Fi. Li-Fi technology, proposed by the German Scientist — Harald Haas, Harald Haas proposed the technology that transmits the data through illumination .Li-Fi is ideal for high speed wireless data transmission in confined area. Li-Fi provides higher bandwidth, efficiency, availability and security than Wi-Fi and has already achieved high speed in the lab. we can implement this system public internet access through street lamps to auto -piloted cars that communicate through their headlights. As the speed of light is higher hence the data transmission speed is so much faster that the existing system. In the future we can implement this technology for fast data access for the laptops, smart phones, and tablets will be transmitted through the light in a room*

***Key Words*: Wireless-Fidelity (Wi-Fi), Light-Fidelity (Li-Fi), Light Emitting Diode (LED).**

1. INTRODUCTION

Harald Haas was developed LI-FI and promoted LI-FI in his 2011 TED Global talk by giving Presentation of an LED light bulb to transmit a data with the speed 10 times more faster. As the speed of light is very high so the data transmission speed via the light is also high. Transfer of data from one place to another is one of the most important day -to-day activities. When the multiple devices are connected to the current wireless networks that connect us to the internet are very slow. As the number of devices increasing the internet access, the fixed bandwidth which is available makes it more and more difficult to utilize high data transfer rates and connect to a network. But, radio waves are just a small part of the spectrum available for data transfer. A solution to this problem is by the use of the proposed system. Li-Fi is transmission of data through light by sending data through an LED bulb that varies in intensity faster than the human eye can follow and the faster data transmission speed. Li-Fi is the new technology has used to label the fast and cheap wireless communication system, which is the next optical version of Wi-Fi.

Fig1:Symbol of Li-Fi & Wi-fi

Li-Fi uses light spectrum that send via LED Bulb instead of Gigahertz radio waves for data transfer. This technology communicate with the help of visible light communication spectrum and has no side effect as we know the light is very much part of our life and so much faster. In this spectrum 10,000 times more space is available and also more availability as a LED light bulb and street light are available already. There are some commonly used examples of wireless networks like- traffic control systems, Bluetooth, infrared and ultrasonic remote control devices, VHF radios, professional LMR, SMR, Two way radio including FRS, GPS, cordless telephone, satellite TV etc Wi-Fi connection within the Building and around the 10-100 meter range to connect our Laptops, P.C., palmtops etc. The current paper deals with the visible light communication which may utilize a wide and fast data rate like 500MBPS. Study made comparison between WI-Fi, Wimax, LI-Fi and other important parameters of the communication process. Li-Fi can be the future technology for where data for laptops, PC, smart phones, and tablets will be transmitted through the light in a room. It is more secure because if you can't see the light, you can't access the data. As a result, it can be implemented in high security areas like military where RF communication is prone to eavesdropping. INTRODUCTION Light–Fidelity technology came into existence in 2011.Harald Haas was coined the term LI-FI and promoted LI-FI. Li-Fi is used for enjoying high data transfer rates. Li-Fi is a fast and cheap optical version of Wi-Fi. It is based on Visible Light Communication (VLC) which is used to transmit data using the spectrum of visible light. In Wi-Fi use radio spectrum to transmit data but due to shortage of radio frequencies and risk of interference it having some limitation. Li-Fi uses visible light instead of Gigahertz radio waves for data transfer. VLC is a data communication medium, which uses

visible light between 400 THz and 800 THz as optical carrier for data transmission and illumination. Li-Fi is the wireless communication system which transmission of data through illumination. Li-Fi is transmission of data through an LED light bulb that varies in intensity faster than the human eye can follow. Li-Fi is a framework for providing new capabilities to current and future services, applications and end users.

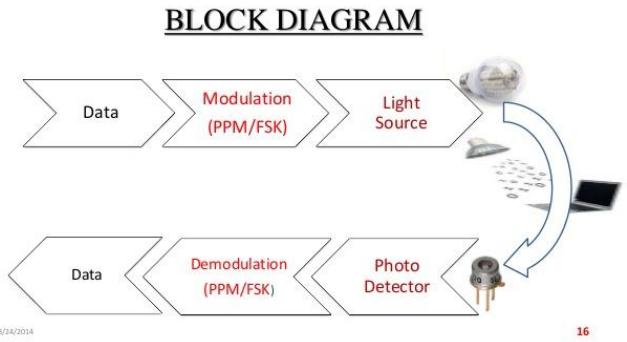

Fig2: Block Diagram of Li-Fi Technology

2) HISTORY AND FUTURE OF LI-FI

The technology underpinning Li-Fi was pioneered by German Physicist Harald Hass, currently based at niversity of Edinburgh in UK. Haas coined the term Li-Fi(Light Fidelity) in 2011 in the context of a talk presenting the new technology at the TED (Technology Entertainment and Design) Global conference.[7][17] The word quickly entered common parlance as an instantly recognizable alternative to Wi-Fi. Both terms are examples of abbreviations linguists sometimes describe as clipped forms(i.e. Wi-Fi=wireless fidelity, Li-Fi= light fidelity).[15]Haas's research project, originally known as D-light(short for Data Light), is now set to launch a prototype Li-Fi application under the name of newly-formed company VLC(Visible Light Communication) Ltd., which was setup to commercialize the technology.[16] The Li-Fi technology can be used for various purposes, it matters the data transmission through LEDs thus all the screens which illuminate light can be served as a platform for data communication. The screen of the mobile phone, television, bulbs can act as a source of light. On the other hand, the receiving platform, the photo detector can be replaced by a camera in mobile phone for scanning and retrieving data. Its other applications are Li-fi for desktops, smartcard Li-fi, Li-fi for schools, hospitals, Li-fi in cities, smart guides, museums, hotels, fairgrounds, events indoor and LBS(Location-based Services), access control and identification crisis, malls, airport and dangerous environments like thermal power plants.[8][11].

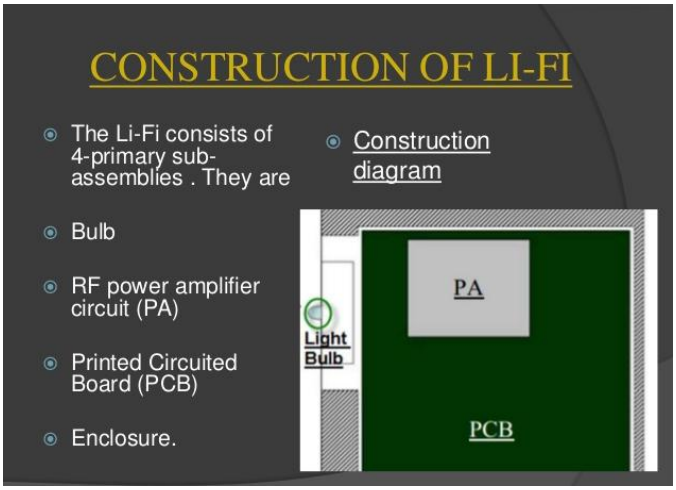

Fig3: Construction of Li-Fi

3. LITERATURE SURVEY

Using a standard white-light LED, researchers at the Heinrich Hertz Institute in Berlin, Germany, have reached data rates of over 500 megabytes per second [1]. Li-Fi Consortium was formed in October2011 by a group of companies and industry groups to promote high-speed optical wireless systems and overcome the limited amount of radio based wireless spectrum. According to the Li-Fi Consortium, it is possible to achieve more than 10 Gbps of speed, theoretically which would allow a high-definition film to be downloaded in just 30 seconds [2]. Researchers at the University of Strathclyde in Scotland have begun the task of bringing High-speed, ubiquitous, Li-Fi technology to market WANG Jia-Yuan, ZOU Nian-Yu, WANG Dong, IRIEKentaro, IHA Zensei, NAMIHIRA Yoshinori .The Journal of China Universities of Posts and Telecommunications. In this paper, the illumination of the receiving surface for different distances between the LED and photodiode receiver was tested. It was found that with the increase in communication distance, the illumination sharply reduced [3].

4. PRINCIPLE

Light Fidelity or Li-Fi is a Visible Light Communications (VLC) system running wireless communications travelling at very high speeds. Li-Fi uses common household LED (light emitting diodes) light bulbs to enable data transfer, boasting speeds of up to 224 gigabits per second. The basic idea behind this communication scheme is transmission of 'Data through illumination' .Heart of Li-Fi technology is high brightness LED's. The on-off activity of LEDs enables a kind of data transmission using binary codes mode however the human eye cannot perceive this change and the LEDs appear to have a constant intensity.

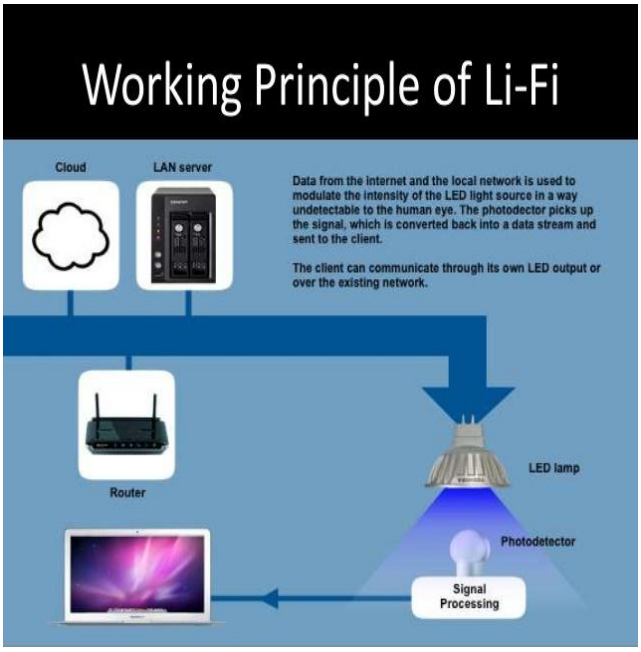

Fig4: Working Principle of Li-Fi

5. COMPARISON BETWEEN LI-FI AND WI-FI

Li-Fi name is used to describe VLC technology which applied to achieve high-speed wireless communication. It acquired this name because of the similarity to Wi-Fi which works well within buildings for general wireless coverage while the Li-Fi is an ideal option for high-density wireless data coverage. Table 1 shows a comparison of transfer speed and data density of various wireless technologies. It seems that Wi-Fi technology offers high data rate, about 150 Mbps, comparing with others current wireless technologies.

Parameters	Li-Fi	Wi-Fi
Speed	High	High
Range	Low	Medium
Data Density	High	Low
Security	High	Medium
Reliability	Medium	Medium
Power Available	High	Low
Transmit/Receive Power	High	Medium
Ecological Impact	Low	Medium
Device-to-device connectivity	High	High
Obstacle Interference	High	Low
Bill of Materials	High	Medium
Market Maturity	Low	High

Fig5: Comparison between Li-Fi and Wi-Fi

6. ADVANTAGES OF LI-FI

Li-Fi technology is based on using a light source for transferring data and no matter which part of the spectrum, visible or invisible, is used [7]. It supports the user with more than sufficient communication speed for downloading movies, music, games and all in very less time. In addition, it removes the limitations which have been put on the Wi-Fi users. a) Capacity: light has 10,000 times wider bandwidth than radio wave which gives the Li-Fi better capacity [11]. b) Efficiency: Li-Fi is highly efficient because of the LED lights consume low energy [9]. c) Availability: they are billions of light bulbs worldwide which just need to be replaced with proper transmission of data LEDs. Possibly in the future, every street light could be free hotspot [3]. d) Security: Light waves are more secure than electric waves because they cannot penetrate through walls. Therefore, the Li-Fi signal can't be intercepted and misused. e) Utilization: Li-Fi can be used in places where Wi-Fi cannot be used or barred such as under water, aircraft cabins and nuclear power plant. f) Safty: unlike radio frequencies, Li-Fi cannot penetrate human body [12].

7. LIMITATION OF LI-FI

Li-Fi technology like any other technology has some limitations which enumerated below: a) The major demerits of Li-Fi is that the artificial light, data transmission, can be obstructed by an opaque material, then the signal will be cut out. b) It works only if there is line of sight between transmitter and receiver [13]. c) Reliability is another shortcoming because of the interface from external light sources such as normal bulbs and sunlight [1, 5]. d) The major challenge is how the receiver will transmit data back to the transmitter [5]. e) Coverage area is as another issue because Li-Fi using very high frequencies, 400-800THz, which limits the coverage area to very short distance (practically, 500Mbps over four feet and 120Mbps over 65 feet) [2].

8. LI-FI APPLICATIONS

There are numerous applications of Li-Fi technology, from providing internet access through street lamps to allowing auto-piloted cars communicate through their headlights [7]. Some of the future applications of Li-Fi technology are as follows:

a) Medical Applications: Li-Fi technology can be implemented in hospitals where using Wi-Fi is unsafe due to radiation concerns. Wi-Fi signal is banned inside operation theatres because it might block signal for monitoring equipment like MRI equipment. However, Li-Fi can be beneficial for robotic surgeries [7, 12].

b) Road Safety and Traffic Management: vehicles can be communicates using Li-Fi through the LED lights to avoid

collation and. Therefore, occurrences of accidents can be reduced [2].

c) Smart lighting: any light source, private or public like street lamps, can be used for providing Li-Fi hotspot as well as for lighting.

d) Aviation: Aircraft cabins already have LED lights which can be used to provide high-speed Internet access [14].

e) Underwater communication: Li-Fi can work underwater where Wi-Fi fails completely. Using Li-Fi in underwater ROVs (Remotely Operation Vehicles) will allow them to communicate with each other using light source instead of using cables. Also, divers can be communicates using their headlamps [7].Li-Fi emits no electromagnetic interference and so does not interfere with medical instruments, not is it interfered with by MRI scanners as its frequency is in visible spectrum as shown in below diagram.

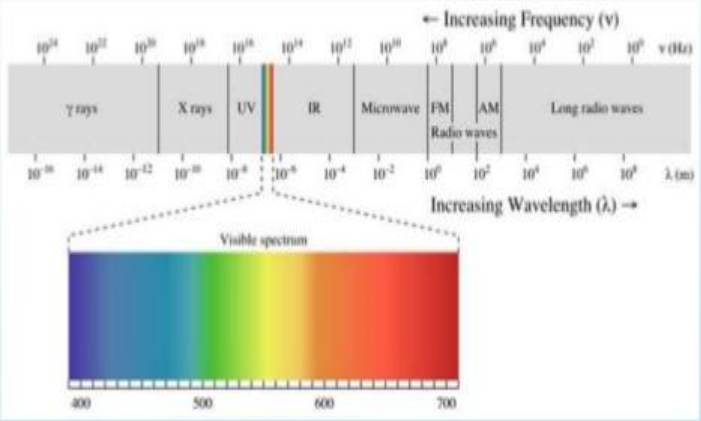

Fig6: Hospital and Healthcare application Li-Fi Technology

9. RECENT ADVANCEMENTS IN LI-FI

The Li-Fi Consortium emphasizes that it is possible to get speeds greater than 10 GHz using Li-Fi technology [1]. In the beginning, over 500 megabytes per second (data rate) was achieved by researchers at the Heinrich Hertz Institute in Berlin in Germany using a stander white-light LED [1, 15]. Then, Harald Hass' groups with researchers from universities of Cambridge, St, Andrews, Oxford and Strathclyde have used an array of LEDs with multiple colours to get high band width linking over few meters [1, 7]. Recently, Li-Fi Consortium created a new Li-Fi system which could receive and send data at rates 110Mbps using red, blue and green LEDs as both emitter and photodiodes for detecting light. They developed their system to transmit data at the speed of 1.1Gbps over 10 meters [1]. Sisoft (Mexican company) and researchers from Autonomous Technological Institute of Mexico (ITAM) claimed that they have used LED lamps for transmitting data in one direction, with data rate 10Gbps, while simultaneously lighting the room [7]. More recently, 224 Gbps bi-directional speed over 3 meters was achieved by University of Oxford researchers using IR technology. This speed will allow 18 movies, 1.5 GB each, to be download in a single second [1]. Finally, researchers at Leeds University achieved 20 Gbps, indoor VLC using laser diodes (LDs) [16]. Scope of Li-Fi Technology Industry For: Transparency Market Research: Some of the leading enterprises operating in the Li-Fi market include Philips, LVX, PureLifi, GE, Oledcomm and others. The majority of these market players are focusing on strategic collaborations, mergers, and acquisitions to gain a competitive edge. For instance, GE recently collaborated with Qualcomm to merge big data and lighting to transform the retail experience. In 2015, LVX partnered with NASA to introduce products for space missions and design new applications for VLC.

10. LIFI OVER OTHER TECHNOLOGIES

LiFi can be used at places where other waves like radio waves or sound waves have limitations. LiFi also provides additional features like high data rates and security. Applications of LiFi include:

- Cellular Communication: LiFi can provide higher data rate (especially high downlink) and security in comparison to WiFi for short distances.

- Hospitals:LiFi can be integrated into medical devices and can be used in hospitals where WiFi is banned as it emits electromagnetic interferences with medical instruments and MRI Scanners.

- Aviation: LiFi can use LED lights which are already deployed in airplanes. Using LEDs for communication can reduce heavy cabling and add flexibility to seating layouts in passenger cabins.

- Underwater Communications: Radio waves are quickly absorbed in water and acoustic waves disturb marine life, but LiFi using light signals can be used as an alternative to this problem for short-range underwater communications.

- Vehicle & Traffic management: LEDs can be used in head-lights, tail-lights, street lamps, signage and traffic signals for vehicle-to-vehicle and vehicle-to-roadside communications. This can avoid road accidents and make traffic control more intelligent.

- Hazardous Environments: LiFi uses light signals for communications, so it can provide a safe alternative to electromagnetic interferences from radio frequency communications in environments such as mines and petrochemical plants.

- RF Spectrum relief: Due to excessive usage of radio waves for communication, we may face a shortage of

radiofrequency bandwidth. LiFi can be used as an alternative to radio waves for short distance communication.

• RF Avoidance: Some people claims that radio frequency used in mobile and WiFi communication can cause brain cancer. So, LiFi is a good solution to this problem.

CONCLUSIONS

Li-Fi has great potential in wireless data transmission field. It offers tremendous scope for future innovation and research instead of it still in its incipient stages. Every bulb can be used as a Wi-Fi hotspot for transmitting wireless data if Li-Fi technology put into practical use. This technique will help to create the cleaner, safer, greener and a resplendent future. Additionally, it will allow internet connection where Wi-Fi is banned in some places such as aircraft and operation theatres. However, one of the shortcomings is that it works in direct line of sight only. Li-Fi is the future technology of data transmission. Since it is easy to generate light waves, it is very advantageous and easily implementable in various fields. Hence the future application can be extended to the various fields like Traffic.

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